TOBACCO CURING

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THE quality of the final product in tobacco culture depends on the condition of the leaf as harvested and on proper handling in curing. The leaf loses much of its water content during curing, but the process is in no sense simple drying. Besides water, the leaf also loses about a fifth of the dry matter and in doing so undergoes chemical changes that develop desirable leaf qualities.

Three methods of curing are practiced—air, flue, and fire curing. The grower can know what methods are best by acquainting himself as far as possible with the nature of the fundamental changes that take place in the leaf while it is being cured and learning the best conditions for bringing about these changes.

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TOBACCO CURING

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METHODS of curing tobacco differ radically as applied to the large number of distinct types produced. There are three essentially different ways of curing: (1) Air curing, in which little or no artificial heat is applied; (2) flue curing, in which the tobacco is entirely cured by artificial heat and in such a way as to prevent smoke from coming in contact with the leaf; and (3) fire curing, in which the tobacco is partly cured by artificial heat applied by means of open fires made on the floor of the barn, which allows smoke to come in contact with the leaf. These methods, together with various modifications, are here considered separately.

RIPENING OF TOBACCO

In all cases the first requirement for good curing is that the tobacco be harvested when "ripe." The young growing leaf has a deep-green color, showing that it is rich in the nitrogenous constituents that go to make up the living or vital part of the leaf and are active in building up the food supply of the plant. At about the time the leaves have reached their maximum power of manufacturing this food supply,

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the flower head begins to develop. Then the food supply, consisting of carbohydrates and other substances, is carried from the leaf through the stalk into the seed head to furnish the necessary food for its development.

In practice, however, the plant is topped, so that the seeds are not allowed to develop. Topping has the effect of causing secondary shoots, or suckers, to grow from the axils of the leaves. These shoots take food materials from the leaves, so that it is necessary for the grower to remove them. Much of the built-up food materials that otherwise would pass into the stalk then accumulate in the leaves. The result is that both size and body, or thickness, of the leaf are increased.

The surplus food supply that accumulates in the leaf, largely in the form of starch, replaces in part the green coloring matter, thus causing the appearance of a lighter shade of green and of the light-tinted flecks characteristic of the ripe leaf. The accumulation of the starchy material in the leaf also causes it to become brittle, so that it snaps when folded between the fingers—another sign of ripeness. This replacement of the green coloring matter by the starchy material has a most important effect on the color, aroma, elasticity, and finish of the cured leaf. Much of the success in curing tobacco depends on harvesting it at just the right time, when it is neither too ripe nor too green. The degree of ripeness that the leaf must attain for best results in curing varies greatly, however, depending on the type of tobacco grown.

NATURE OF THE CURING PROCESS

If a ripe leaf of tobacco is quickly dried with heat it does not show the desirable properties of cured tobacco. Curing therefore is not simply drying out the leaf—it involves other important changes in composition that can take place only under certain favorable conditions. Again, if a fresh leaf is killed quickly by exposure, in a closed vessel, to the vapors of chloroform or formaldehyde for a few minutes and then placed in the curing barn it will not cure properly. This is because the premature killing prevents curing. In other words, curing is largely a living, or vital, process. The surplus supply of food that the leaf accumulates during the ripening period enables it to live for several days after being harvested. When this reserve food supply is exhausted the leaf dies and is then nearly cured.

Curing tobacco is forcing the leaves to undergo a process of gradual starvation under proper conditions. Anything that kills the leaf prematurely, such as bruising or breaking in harvesting, freezing, or very rapid drying, will prevent good curing. Moreover, the leaf, when harvested, contains a large quantity of water, most of which is lost during the curing. The rate of drying has an important effect on the result of the curing.

CURING PICKED LEAVES COMPARED WITH CURING ON THE STALK

There are two general methods of harvesting the tobacco crop and of arranging it in the barn. In one the leaves are picked from the stalk as they ripen and are arranged on strings attached to sticks

suitable for hanging in the curing shed. In the other the leaves are not removed, but the stalks are cut off near the ground and hung up in the barn, tips downward. As the leaves do not all ripen at the same time, the stalks are cut when they will give the greatest number of the best leaves at the proper stage of ripeness. This causes a considerable sacrifice in leaves, since those at the bottom are overripe and those at the top are still immature, but this process saves labor.

In many cases both methods give satisfactory results when properly carried out. The question as to which is the better in any given case must be decided largely by labor supply, barn space available, and other local conditions, as well as by the relative value of the crop to be cured. Much of the highest priced tobacco is now being cured after the leaves have been picked from the stalk by the method generally spoken of as "priming."

Although either method may give good results, there are undoubtedly differences in the yield and character of the cured product. To understand them, it must be remembered that the leaves and the stalks remain alive for several days, or even weeks, after harvesting, depending on conditions in the curing barn. During this period of gradual starvation, so long as they retain sufficient moisture, the leaves and stalks remain alive by means of the reserve food supply stored up during the ripening process. In either method the loss in weight of the dry matter of the leaf as a direct result of the starvation process is usually 12 to 20 percent.

When the leaves are cured on the stalk there is a further loss in weight from another cause. The movement of food materials from the leaves into the stalk that began in the field takes place also in the curing barn. When the leaves are primed, there is, of course, no chance for such movement from leaf to stalk. The result is that leaves cured by priming are 10 to 12 percent heavier than those cured on the stalk.

It has also been found that leaving suckers on the stalk at the time of harvest results in a still greater loss of weight in curing the entire plant. Furthermore, picking the lower leaves causes those left on the stalk to increase in size and weight, so that altogether the gain in weight is fully 20 to 25 percent when the tobacco is harvested in this way.

When curing on the stalk is practiced, the longer curing period and the movement of materials from the leaf into the stalk also affect the quality of the cured tobacco. Other things being equal, the picked leaves will have more of the so-called oil or gum, greater elasticity, and more body than those cured on the stalk. Which method gives the better quality must be determined separately for the different classes or types of tobacco.

The above-mentioned facts apply more particularly to the usual methods of harvesting and curing cigar tobacco. In fire curing and especially in flue curing on the stalk (a method now obsolete), the life of the stalk is greatly shortened by the higher temperatures used, so that there is less opportunity for the transfer of food materials from leaf to stalk. In these circumstances there is less difference in yield and quality of cured leaf between priming and curing on the stalk. The applications of the two methods of harvesting are considered in detail in later paragraphs relating to the curing of the various types.

AIR CURING

Nearly all the cigar tobaccos, wherever produced—the immense quantities of burley and other manufacturing tobaccos grown in Kentucky and adjoining States, the Maryland, and the Virginia sun-cured types—are air-cured. That is, they are cured without the use of artificial heat except, in some cases, during periods of wet weather. The tobacco is placed in the barn in the ripened state, usually after having been wilted, and curing is controlled simply by regulating the ventilation.

During the first stage of curing, while the leaf is undergoing starvation, it is also gradually losing the water it contains. One of the most important features of curing is to properly regulate the rate of drying. If drying is too rapid the leaf is killed prematurely and curing is stopped; if drying is too slow, curing goes too far. The rate of drying depends principally on the humidity in the barn. The fully ripe leaf is rich in starch, and one of the important changes in curing is the disappearance of this starch, which is consumed largely by the living part of the leaf itself.

If the leaf is killed by bruising, rapid drying, or too high heating there is no means of removing this starch, and the tobacco is harsh, lifeless, and "strawy." Some of the nitrogenous constituents also are changed during this starvation period. These are the first changes necessary for curing.

Along with these changes in composition the green color is replaced by a lemon yellow. If, by bruising or rapid drying out, the green leaf is killed outright soon after harvesting, the green color cannot be removed by any later treatment. If, however, the leaf remains alive 2 or 3 days under good curing conditions, any green color then remaining can be removed by sweating or fermentation.

The full development of the yellow color marks the end of the first period of curing. The changes taking place in the second stage are for the most part quite different. After the leaf is dead no more of the starch is consumed, nor are the insoluble nitrogen compounds further altered. One of the most important changes in the second stage is in color—from yellow to brown or red. This is caused by a process of oxidation that does not take place till the cells of the leaf are dead. The two conditions necessary for the development of the brown color are a supply of air and sufficient moisture. In air curing the principal danger is that, because of excessive moisture, the change will go too far, causing the tobacco to cure too dark.

As regards weight, the most important change in curing is in the loss of water. The tobacco leaf ordinarily loses about 75 percent of its green weight in curing, and most of this loss by far is in water. Thus, the tobacco from an acre yielding 1,800 pounds of cured leaf weighs when harvested something like 8 tons, including the stalks. Of the 8 tons fully 6 tons is water. To cure tobacco successfully most of this must be removed under such conditions and at such a rate as will best allow the other important changes to take place.

CONDITIONS MOST FAVORABLE FOR AIR CURING

The living cells of the leaf are killed by excessively low or high temperatures and by loss of water. In practice the most favorable temperatures for the first stage of air curing lie between 70° and 100°

F., and the relative humidity should be about 85 percent. Under these conditions the leaf will gradually lose its water, but will not become brittle, and curing will proceed smoothly. If the humidity becomes much higher, pole-sweat will develop on the leaves most advanced in curing, while if the humidity falls much below this figure the leaf will dry out too rapidly.

In the second stage of curing, when the leaf begins to turn brown, there is no longer any need for keeping the air in the barn so moist, and the leaf should be allowed to dry rather rapidly until the stems have become brittle. It is desirable to prevent the tobacco from coming into very high "case"—that is, from becoming very moist after curing and before it is taken down—so it should be stripped and sorted as soon as possible after curing is completed.

Unfortunately, growers have very limited means for controlling the temperature and humidity in the barn in the air-curing process. If the season is too dry the tobacco "hays down"—that is, it simply dries out like hay; if too wet, it is also seriously damaged.

Serious damage to the tobacco crop results from lack of means for maintaining proper barn conditions during the curing period. This loss can never be overcome until satisfactory methods are provided for conducting the cure independently of outside weather conditions. All experienced tobacco growers are aware of the serious damage likely to result from pole-sweat, or house-burn, during periods of very wet weather. Few, however, fully appreciate the extent of the injury in quality caused by the opposite extreme of excessively dry weather.

POLE-SWEAT, OR HOUSE-BURN

Pole-sweat, or house-burn, which is especially to be looked for during periods of prolonged wet weather accompanied by rather high temperatures, occurs the world over where tobacco is cured without the use of heat. It is caused by minute organisms that attack those parts of the leaf that give it toughness and stiffness, causing it to soften and decay. Pole-sweat does not occur until after the leaf tissue dies, but since some parts of the leaf may die much sooner than others, the disease may appear before the entire leaf is dead. As the organisms that cause this trouble are not active at very low temperatures, pole-sweat does not appear to any extent in cold weather. Furthermore, they thrive only in the presence of an abundance of moisture.

The three conditions necessary for the rapid spread of the disease are (1) tobacco that has passed through the first stage of the cure or has been killed by bruising or other injury; (2) a temperature ranging from 60° to 100° F.; and (3) a relative humidity of 90 percent or more, which checks the evaporation from the leaves, causing them to become soggy. Conditions favorable to pole-sweat may exist for short periods without the appearance of the disease, but it will certainly develop if these conditions continue for 24 to 48 hours.

The remedy for this trouble lies in controlling the humidity in the curing barn during periods of excessively damp weather. The only practicable means for accomplishing this is to use artificial heat. This subject is considered in the discussion of methods of curing cigar tobaccos.

HEAT AND VENTILATION

Air curing, pure and simple, gives satisfactory results only when weather conditions are favorable. When the weather is unfavorable, artificial heat must be applied. At the time the tobacco is hung in the barn, water is evaporating from the surface of the leaves. This evaporation continues until the surrounding space is saturated with moisture. Hence, the evaporation from the fresh leaves will soon cease unless the moisture is removed by circulating the air. In moderately dry weather ventilation is all that is needed to obtain favorable curing conditions, provided the temperature is not too low. In very dry weather the evaporation from the leaves can be kept in check by having the barn built as tight as possible and by keeping the ventilators closed during the day. If the temperature is low, curing changes are stopped, although the tobacco may continue to dry out. In this case the leaf is simply dried and not cured.

During rainy or foggy weather the air is practically saturated with moisture, and since it cannot take up any more, ventilation alone is then useless. The capacity of the air for holding moisture in a given space is greatly influenced by the temperature. By raising the temperature about 20° F. we double the capacity for holding moisture. In wet weather artificial heat is required to reduce the humidity in the barn. With suitable means of maintaining the barn temperature at 15° to 20° higher than that of the outside air, combined with proper ventilation, the problem of controlling curing conditions is solved. An insufficient quantity of heat is worse than none, and enough must be supplied to warm the barn to the top and thus drive out the moisture. When the temperature is below 50° heat is needed for good curing regardless of the humidity, for while the tobacco may dry, it cannot cure properly at low temperatures. Methods of applying artificial heat in air curing are discussed under Cigar Tobaccos.

CIGAR TOBACCOS

The bulk of the cigar-tobacco crop is grown in Massachusetts, Connecticut, New York, Pennsylvania, Wisconsin, Ohio, Florida, and Georgia. The finest grades of wrapper leaf are grown in the Connecticut Valley and in a few counties of western Florida and southern Georgia. Wisconsin is known as a binder State. New York, Pennsylvania, and Ohio produce mainly filler grades. All cigar tobaccos are air-cured under general methods of procedure essentially the same. In curing the wrapper types, however, some artificial heat is used.

Barn Construction

In building a good tobacco barn two essentials are to construct it as nearly airtight as possible and to provide a good system of ventilation. The site chosen should be thoroughly drained and sufficiently removed from other buildings to allow free access of air. It should be as near the tobacco field as possible for convenience in harvesting. The barns may be 30 to 40 feet wide and of any convenient length up to 300 feet or even more, but the shorter barns are preferable.

The interior should consist of a framework carrying poles for supporting the laths bearing the tobacco. The spaces between the poles

are called tiers. Many barns are built four tiers high, but the curing can be better controlled when the building is only three tiers high to the plate. The tobacco should not hang within 3 feet of the ground, so that the first tier of poles should be at least 7 to 9 feet from the ground and the other tiers 4 or 5 feet apart.

The posts, plates, and beams used for the frame of the barn should be of stout timbers securely braced to carry the enormous weight of the green tobacco and to withstand heavy winds. In the usual type of barn, the posts, frames, and girders are set up across the barn at intervals of about 16 feet, the same as at the ends, thus dividing the framework into sections known as bents. The girders on the ends and on bents for carrying the lower tier of poles usually are made removable, while those for the upper tiers should be well braced. The tier poles on which the tobacco is hung are usually about 16 feet

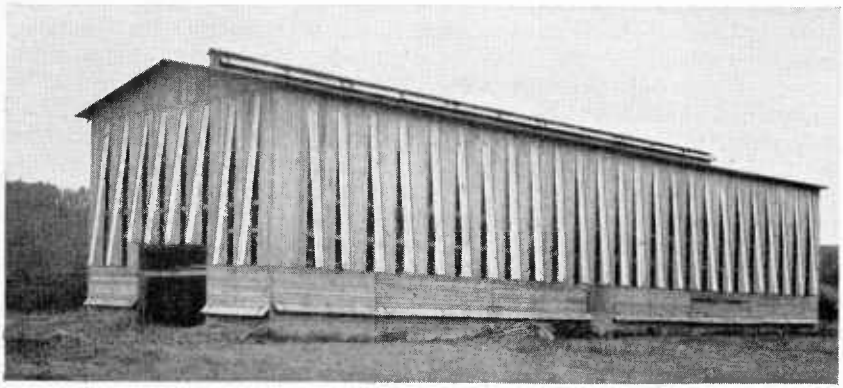

Figure 1.—A good type of barn for curing cigar tobacco, with vertical ventilators on sides and horizontal ventilators on peak of the roof and near foundation. The ventilators along the peak are also adapted for the use of heat in curing.

long, and should be stout enough to carry at least 800 pounds. The horizontal distance between the poles should be 4 feet.

The boards for the sides and ends of the barn should be of uniform width (10 or 12 inches), and all cracks should be battened with thin strips so as to make the structure as nearly weatherproof as possible. At least every third board should be hung on hinges as a ventilator. If the boards are put on horizontally, those used for ventilators should be hung from the upper edge. If put on vertically, the boards used for ventilators may be hung either from the top or side. Extending along the entire length of the sides a horizontal bottom ventilator should be provided for admitting air near the ground. Comparatively few barns have any provision for ventilation in the roof, such as is shown in figure 1, but this is a desirable feature when artificial heat is applied in unfavorable weather.

The barn usually has driveways extending through it. Doors are provided at each end, of sufficient size to allow a team to be driven through without difficulty.

The construction of the barns used for curing cigar leaf in the southern districts is essentially the same as that of the barns in northern districts, except that the ventilators often consist of openings at

intervals of about 8 feet, 2½ to 3 feet wide and 10 feet long, with shutters suspended at or near the top. A good type of barn fitted with a system of vertical ventilators, as well as ventilators along the peak, is shown in figure 1.

Management

The greater part of the cigar tobaccos is cured with the leaves attached to the stalk, although in the wrapper sections harvesting by priming, or picking the leaves from the stalk, is practiced. Curing picked leaves is discussed further in connection with curing shade-grown tobacco.

The first step in promoting good curing is the thorough wilting of the leaves. If the weather is cold or wet, it is desirable to apply artificial heat to hasten the wilting, and if the weather continues unfavorable the heat should be kept up for 2 or 3 days. Sufficient ventilation to take off the excess moisture must be provided. On the other hand, too rapid drying must be avoided. Many growers in their anxiety to avoid damage from pole-sweat, caused by excessive moisture, injure their tobacco seriously by going to the other extreme of drying the leaf so rapidly as not to allow sufficient time for the essential changes to take place. The aim should be to wilt the leaf as soon as possible and then to check the drying, but also to maintain a warm temperature until the leaf yellows. If no heat is applied, ventilation alone must be relied on to bring about these conditions.

As soon as the yellow color begins to develop, the drying should be hastened, for the development of the brown color, which soon follows, indicates that the leaf is beginning to die, and this is the critical stage in the cure. If the humidity remains very high at this stage for any considerable period, pole-sweat will develop. This is to be especially feared if a season of warm damp weather sets in. The only remedy lies in the use of artificial heat to keep down the humidity. Whether or not used in the first stages, heat is absolutely necessary to prevent damage under the severe conditions of pole-sweat, and it must be kept up until the leaf is pretty well dried out. Ventilation alone will be of little value.

Aside from the danger of pole-sweat, however, there are other important reasons for reducing the humidity in the barn as soon as the brown color begins to develop. At present the demand is for bright colors in wrapper leaf, and the longer the second stage of the cure is protracted by a relatively high humidity the darker will be the leaf. Again, each time the tobacco comes into high case, after the cure is finished, the color will be further deepened. Finally, if the tobacco at this stage remains moist for a long period, it undergoes a sort of cold sweat and does not ferment so well when put in the case or in bulk.

After the cure is finished, the tobacco should be prevented from coming into high case, or order, until it is to be taken down, as far as this is possible. Sunlight injures the color of tobacco; hence, the sun should not be allowed to shine on the leaf in the barn. Wind may bruise the leaf near doors and ventilators, unless these are carefully watched and regulated.

The time required for completing the cure varies from 5 to 8 weeks, depending on weather conditions. Quick curing may be depended on to give the best results, provided the first stage is not unduly hastened.

The cure is finished when the midrib of the leaf is dried out so that it will snap when bent between the fingers. When the tobacco is ready to be taken down the stalks may be still quite green.

Method of Applying Heat

It is important not only that heat be applied for good curing of cigar tobaccos in cold or excessively wet weather, but also that it be applied in the right way. Artificial heat has not been utilized to any extent in curing filler or binder types, but its use has become general in the wrapper districts in curing tobacco harvested by priming the leaves.

Small charcoal fires built on the floor of the barn have been in use for some years in Florida and the Connecticut Valley, especially in curing shade-grown tobacco. To get proper distribution of heat a large number of fires are required, and but little ventilation should be used during the firing. Charcoal is an expensive fuel, the supply is often limited and uncertain, and it is quite a task to care for the large number of fires required. Unless some better or cheaper method is available, however, charcoal fires should be freely used for curing cigar tobaccos when the weather is unfavorable.

Stripping and Sorting

After cigar tobacco is cured, the plants should be taken from the laths as soon as possible and the leaves stripped off. This cannot be done, however, until after damp weather has prevailed long enough for the leaf to become sufficiently pliable to be handled readily without breaking. Tobacco in this condition is said to be "in case" or "in order." Weather well adapted to bringing it into case is spoken of as a "tobacco storm." Tobacco will not come into order if the temperature is very low, even during wet weather. If the stalks have been frozen it is well to let the plants hang until dripping stops, so as to avoid staining.

As the plants are taken from the laths they are usually piled in heaps on a floor of poles or boards, the tips all turned inward and overlapped to prevent the leaves from drying out. To avoid the heaps becoming heated, stripping should be done as soon as possible. In some of the filler districts dampening cellars are used in bringing the tobacco into case, and the plants are taken from the cellar to a sorting room for the stripping.

The leaves, as stripped from the stalk, are placed in one, two, or three grades—based largely on length and soundness and classed as binders or tops, fillers, and stemming grades—and those of each grade are tied into "hands" of 15 to 30 leaves, using a leaf as a binder. These hands are packed into cases, and the tobacco is then ready for market; or the leaves are first made into neat bundles or bales by means of a form, wrapped with heavy paper, and tied with twine. These bundles usually weigh 30 to 60 pounds.

Before the leaf is ready for the manufacturer it must undergo a process of fermentation, commonly spoken of as "sweating." Carrying out this process successfully requires a thoroughly equipped plant, with facilities for controlling ventilation, temperature, and humidity. As a rule, therefore, the growers sell their leaf in the bundle to the packers, who make a business of carrying on the fermentation on a large scale.

Curing Shade-Grown Wrapper Leaf

Growing Cuban and Sumatra types of cigar-wrapper leaf under artificial shade is an important industry in the Connecticut Valley and in parts of southern Georgia and western Florida. All shade-grown leaf is picked from the stalk in harvesting, to insure the maximum yield of high-grade wrappers. The barns used are of the same construction as those employed in curing tobacco on the stalk, except that, since the leaves are picked from the stalk in harvesting, the tier poles are only about 2½ feet apart, vertically.

Nearly all shade-grown tobacco is cured in part with artificial heat. Small charcoal fires are made on the floor of the barn, and moderate

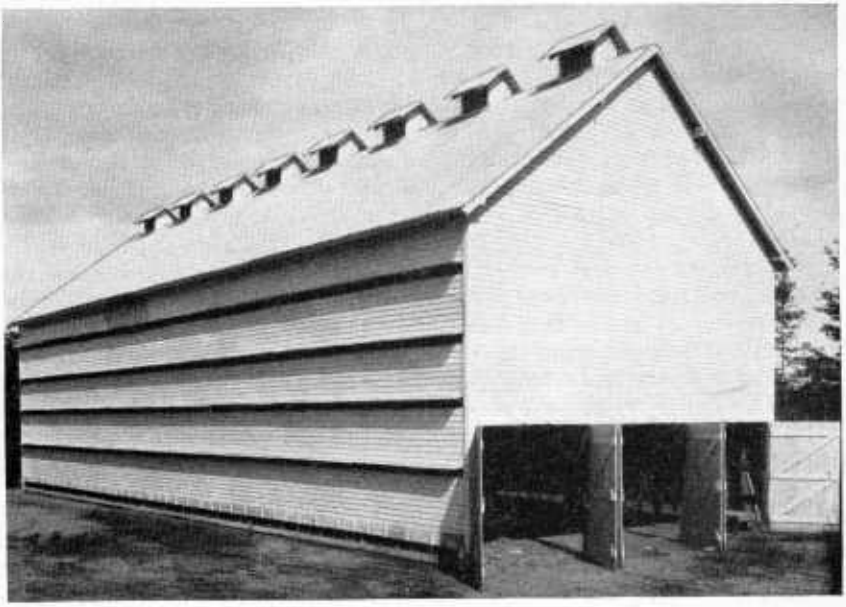

Figure 2.—A modern type of barn for curing burley tobacco, showing horizontal ventilators and ventilators along peak of roof.

heat is maintained for 2 or 3 days or longer, depending on the weather conditions. But little ventilation is given while the fires are going.

As soon as the brown color develops, the leaf may be allowed to dry out rather rapidly. The leaf proper cures down in a short time, but a much longer period is required for completely drying out the stems. The picked leaves are subject to pole-sweat at the critical stage, the same as when cured on the stalk, but the danger period is much shorter. Under favorable conditions curing will be completed in 4 to 6 weeks. The cured leaf is taken down and tied into hands, which are delivered to the packer in either of the ways described in the preceding section.

BURLEY TOBACCO

The bulk of the burley crop is grown in north-central Kentucky, eastern Tennessee and adjoining counties of North Carolina and Virginia, and a few counties of West Virginia, Ohio, and Indiana bordering on the Ohio River. Like cigar tobaccos, burley is cured without

the use of artificial heat, except when there is danger of injury from pole-sweat, or house-burn. The many types of barns in use for curing burley tobacco range from the small, crude structure to the most approved modern frame building with ample facilities for controlling the ventilation. The modern barns (fig. 2) are essentially the same as those used in the cigar-tobacco districts, discussed on page 6.

Management

The method of curing burley tobacco is the same as that for cigar tobaccos, and the leaf changes that take place are of the same kind. When cured, however, the leaf is a pale yellowish to a reddish brown instead of the characteristic clearer and deeper brown of cigar leaf. In very dry weather the barn should be kept closed during the day and open at night; otherwise, more ventilation is required. In very damp weather the leaf cures down too dark.

Some growers use small charcoal fires or burn coke in stoves to dry out the barn when house-burn threatens. From 4 to 6 weeks is usually required for completing the curing process.

Sorting and Packing

When taken down from the poles, the leaves of burley tobacco are stripped from the stalk and sorted. The usual grades are (1) flyings, (2) trash, (3) lugs, (4) bright leaf, (5) red leaf, and (6) tips. The first four grades are used principally for smoking tobaccos and cigarettes, the best lugs and the bright leaf for plug and cigarette (little cigar) wrappers, and the red leaf and tips for plug and twist fillers. These different grades are tied into hands of 10 to 20 leaves and bulked down. For marketing, the tobacco may be packed into hogsheads, but in recent years it has become the general practice to sell burley by the loose-leaf auction system.

OTHER AIR-CURED TOBACCOS

Tobacco is mostly air-cured in the large territory lying immediately west of the burley district and extending from northern Tennessee through Kentucky into southern Indiana, including the so-called one-sucker and the Green River districts. The construction of the barn and the management of the curing process are substantially the same as in the burley district. As a rule artificial heat is not used, but some growers burn coke or charcoal in long open grates in the barn in unfavorable weather. The cured product is usually sorted into three primary grades—trash, lugs, and leaf, chiefly for export and domestic plug chewing tobacco.

The tobacco grown in southern Maryland, which is used chiefly for domestic cigarette manufacturing and some for export, is air-cured. The barns (fig. 3) are rather simple affairs, resembling some of the older types in the burley and cigar-tobacco sections. The method of conducting the curing is similar to that used in the cigar-tobacco districts when the leaf is cured on the stalk. In preparation for market Maryland tobacco is usually sorted into three primary grades—seconds, bright leaf, and dull leaf. The tobacco is marketed in hogsheads containing 700 to 800 pounds, or by the loose-leaf auction system. Cer-

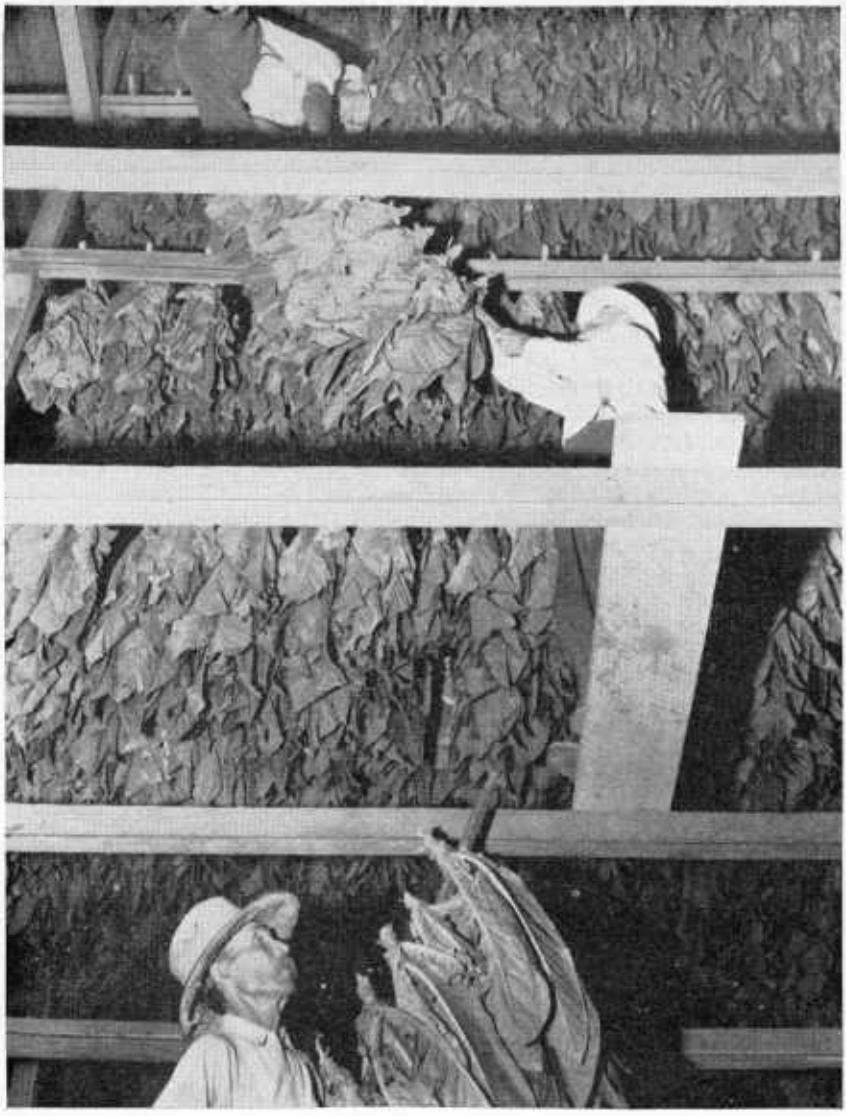

Figure 3.—Hanging Maryland tobacco in the curing barn.

tain grades of Maryland leaf have been used increasingly in the domestic manufacture of cigarettes.

SUN CURING

In Caroline, Louisa, Hanover, and adjoining counties of Virginia a type of tobacco is produced that is known as sun-cured. This name is based on the fact that formerly the tobacco was exposed to the sun or open air for several days immediately after harvesting, the curing then being completed in the barn without the use of artificial heat. Sun-

cured tobacco is used mainly for chewing, and exposure to the sun is thought to improve the flavor. The same general types of barn are used as in the dark air-cured manufacturing districts.

It is a fairly common practice in the fire-cured areas and in Pennsylvania to scaffold the tobacco in the field to induce wilting and partial curing before hanging the tobacco in the barn (fig. 4). This practice is generally thought to hasten the curing process and lessen the house-burn hazard. In typical sun curing, the sticks, filled with the plants, are crowded rather closely together on scaffolds erected near the barn. After the leaves have yellowed, usually 4 to 6 days, the sticks are spread farther apart and left on the scaffold a few days longer. Curing is then completed in the barn.

If there is much rain during the sunning period the tobacco should

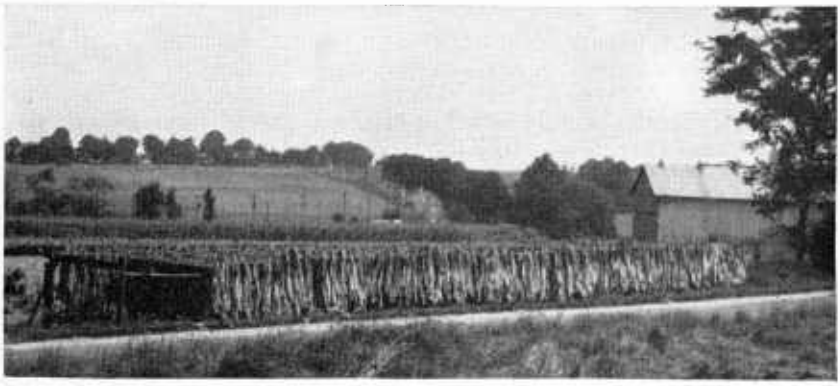

Figure 4.—Pennsylvania cigar tobacco hung on scaffolds to wilt and partially cure prior to being transferred to barn.

be placed under shelter. On account of the increased cost of handling, sun curing is little practiced now, practically all of the tobacco being cured like burley and other air-cured types. After stripping, the leaves are usually sorted into two grades, lugs and leaf, although the best leaves are sometimes placed in a third grade for wrappers.

FLUE CURING

Nearly all the flue-cured tobacco, frequently spoken of as bright tobacco, is produced in southern Virginia, North Carolina, eastern South Carolina, southern Georgia, and northern Florida. The distinctive feature of flue curing is that the barn is provided with a system of large pipes, or flues, that carry off the fuel gases throughout the curing period. Smoke does not come in contact with the tobacco, and artificial heat is used throughout the cure, which is completed within a few days. Furnaces suited to the fuel being burned are employed, and while a barn temperature only a few degrees above that prevailing outside is used at the beginning, a temperature of 170° F. or more is reached at the end of the process.

One of the principal factors controlling the value of the leaf cured by this method is the color, and the prime conditions for success in this respect are the right kind of soil with proper fertilizer, a suitable variety of tobacco, and proper control of the curing.

CHANGES IN COMPOSITION AND PROPERTIES OF THE LEAF

In flue curing, just as in air curing, the principal changes in composition must be brought about before the leaf is killed. The nature of the changes in the two methods is the same, the principal difference lying in their extent or completeness. The typical bright-yellow tobacco at the time of harvesting is riper than most tobaccos cured without the use of heat. Partly on this account and also because of the character of the soil on which it is grown, this type of leaf is richer in starchy matter and poorer in coloring. Flue curing really consists of hastening and shortening the first stage in air curing—the yellowing—while the second stage of air curing, in which the brown or red color develops, is not allowed to take place at all.

BARN CONSTRUCTION

Barns used in curing bright tobacco are comparatively small and simple in construction. They are usually built square, with inside dimensions of 17, 21, or 25 feet, thus providing four, five, or six sets of tier poles spaced about 50 inches apart, center to center. The lowermost tier poles are placed 6 to 7 feet above the ground, and for curing the picked or primed leaves the vertical distance between tiers should be about 2 feet, center to center, while for curing on the stalk, a method formerly employed, this distance should be 2½ to 3 feet. The total height of the barn to the plate may be 16 to 20 feet. Additional tiers may be attached to the rafters forming the roof. The tier poles should run at right angles to the flues.

Formerly barns for flue curing were commonly built of logs, but because of increasing scarcity of timber, frame structures have largely superseded the log barns in some sections. When logs are used the

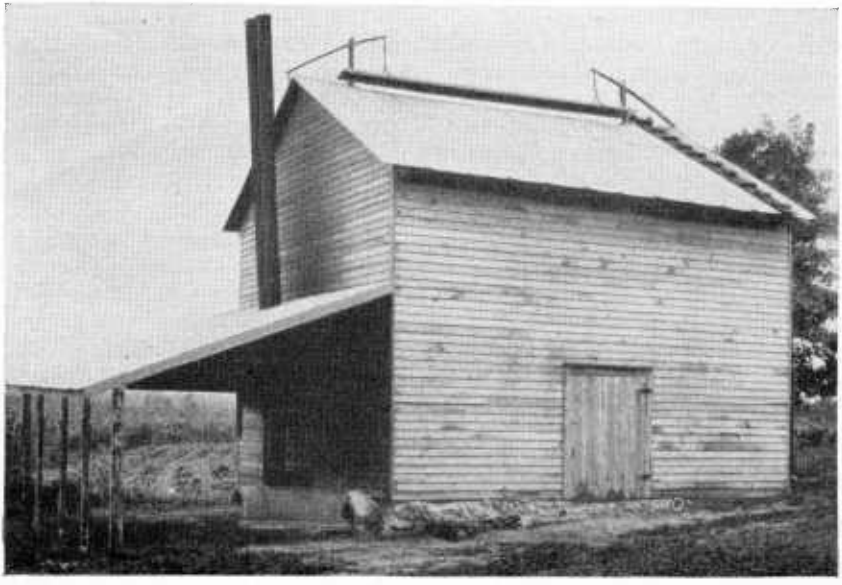

Figure 5.—Barn for flue-curing tobacco, with good roof ventilator and ventilation ports in foundation.

cracks are either chinked with mud or closed with lime mortar. If frame barns are built, all cracks should be battened with thin strips of boards, or, preferably, the walls should be made of two thicknesses of boards with builder's paper between. Ventilation is usually provided by leaving openings around the bottom of the barn and by cutting in the gable ends near the roof small windows that can be opened when desired. Many barns contain so many cracks and crevices, espe-

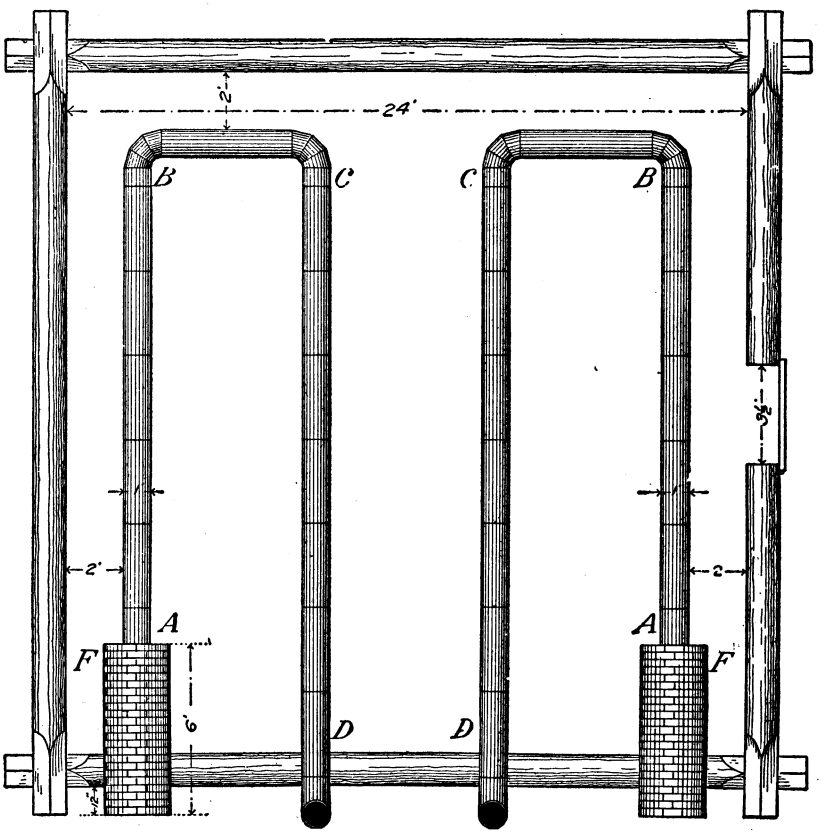

Figure 6.—Floor plan of furnaces and flues in a flue-curing tobacco barn: *A, A,* Fire joints at furnaces (*F, F*); *B, B,* and *C, C,* flue elbows; *D, D,* points (1 to 2 feet higher than at *A, A*) where flues pass outside to smokestacks. Instead of elbows at *C, C,* a T-joint would lead to a single stack instead of two (fig. 5).

cially about the roof, that they require no special ventilators, but such barns are poorly adapted to flue curing. A good type of barn, fitted with an improved roof ventilator and ventilator ports in the foundation, is shown in figure 5. Hollow concrete tile or hollow clay tile fire-resistant barns are now coming into use, and because of their greater safety and more permanent character it appears that they may replace some of the wooden structures; however, for efficient heat utilization some form of insulation is required.

The heating system consists of a series of sheet-iron flues leading from small furnaces placed at one end of the barn. The arrangement

of the flues is comparatively simple, but is variously modified in different sections of the flue-curing belt. One of the best arrangements for the larger sized barns is that shown in figure 6. The furnaces (fig. 6, *F*, *F*) are built of stone or brick and are usually about 18 inches wide and 15 to 20 inches high, inside measurement, and 5 to 10 feet or more long and project a short way outside. The flues, 10 to 12 inches in diameter, are made in sections similar to ordinary stovepipe. They are fitted into the ends of the furnaces at *A*, *A*, and extend across the barn to *B*, *B*, where they turn at right angles, and, continuing to *C*, *C*, they once more turn at right angles, and, being inclined slightly upward throughout their length, pass out through the barn wall at *D*, *D*, at a point 1 to 2 feet higher than the mouth of the furnace. Smokestacks of varying height, preferably extending above the roof, are fitted to the outer ends of the flues.

This arrangement of the flues may be modified in a variety of ways. The two flues may be united at *C*, *C* (fig. 6), with a single arm returning to the side of the barn from which the furnaces enter, thus giving three lengths of pipe across the barn instead of four. In the smaller barns a single furnace is placed in the center of one end and a single flue leads across the barn and then branches at right angles, each arm returning along the side walls, thus simply reversing the last described arrangement. Whatever arrangement is used, the flues should be placed at least 18 inches from the walls of the barn.

USE OF FUEL OIL AND COAL FOR CURING

Formerly wood was practically always used as fuel in flue curing tobacco, as it was available on the farm in many instances and if purchased was not expensive. More recently fuel oil and coal have become widely used as fuel, owing to the scarcity of wood and its high cost and also because of the saving in skilled labor. Both oil and coal burners are usually operated by thermostat or other means of automatic control and so require greatly reduced supervision. Further, as such operation is not subject to the unavoidable variations in the heating accompanying any system of manual firing, more uniform curing conditions are obtained, with resulting improvement in the quality of tobacco produced. Several types of oil burners are employed, but for burning coal automatic stokers such as used for house heating, with suitable controls, have been used (fig. 7).

When oil burners of the type in which the products of combustion are liberated within the barn are used, special care in their operation and maintenance is required in order to insure proper combustion of the fuel. Obviously, smoking or improperly operating burners will result in contamination of the tobacco, making it unsuitable for the usual manufacturing purposes. Under prevailing economic conditions, coal burned in automatic stokers is the cheapest fuel for curing.

CONDITIONS AFFECTING RATE OF CURE

A number of formulas or rules are in use in curing bright tobacco, any of which will give satisfactory results in certain cases. The differences are due partly to differences in the tobacco when harvested and partly to the fact that all the formulas are based simply on the temperature in the barn, with scarcely any reference to the humidity,

which is really the more important factor in curing. The principal use of the artificial heat is to regulate the humidity, and evidently this is affected by the quantity of water in the tobacco and the prevailing weather conditions.

The capacity of the air for holding moisture, and consequently its drying capacity, depends principally on its temperature, and air that is already saturated has no drying power until its temperature is raised. In order to control the rate of drying, the temperature of the air in the barn must bear a certain relation to that outside. The cor-

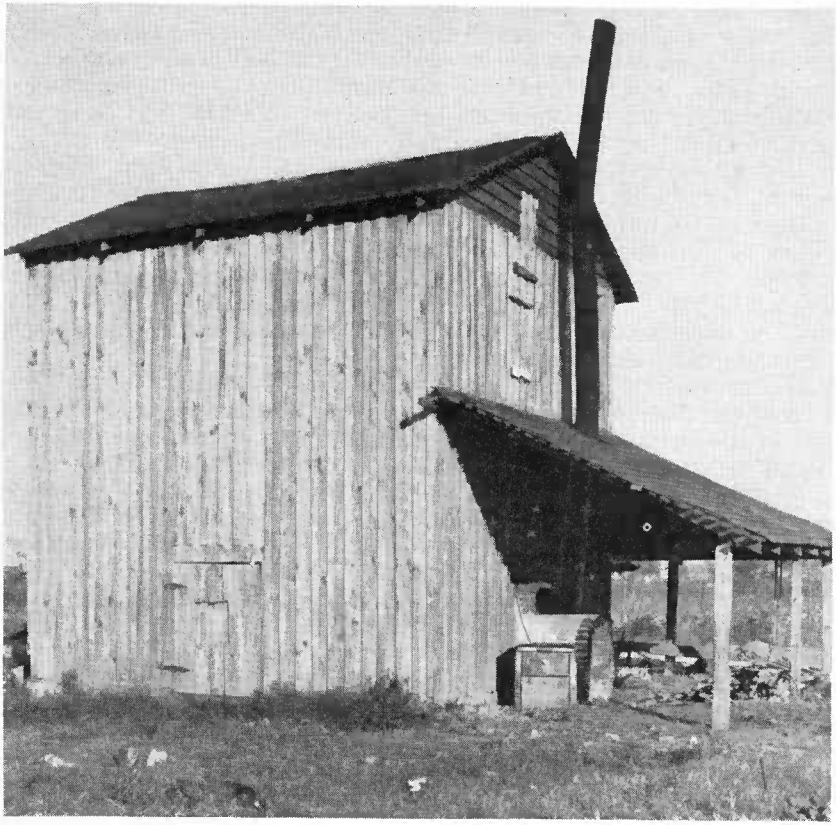

Figure 7.—Flue-cured tobacco barn, showing stoker.

rect difference in temperature inside and outside will be influenced by the humidity of the outside air. The temperature inside the barn must be higher in warm weather than in cool, and also in rainy or wet seasons than in dry weather.

Another equally important factor in controlling the humidity in the barn is ventilation. The warm moist air in the barn must be constantly replaced by the less humid air outside; hence, proper means of ventilation should be provided, though few growers fully appreciate its importance. In barns built without satisfactory provision for ventilation the only reason that curing can be successfully done is that they are not sufficiently tight to prevent the natural ventilation

caused by the higher temperatures within. Frequently this natural ventilation is insufficient, and at the critical moment the tobacco is badly damaged by discoloration because of excessive moisture. On the other hand, there are times when it is desirable to check the rate of drying, so that it is important to provide at the top and bottom of the barn ventilators that can be readily opened or closed as desired.

MANAGEMENT

It is desirable for flue curing that the barn be completely filled with tobacco in 1 day. A thermometer is hung on the lower tier, near the center of the barn. Small fires are started in the furnaces and a moderate temperature maintained until the leaf is thoroughly yellowed. This requires from 24 to 36 hours. The yellowing may be accomplished at any temperature between 80° and 115° F. It is well to start at 80° or 90° and gradually raise the temperature to 110° or 120° at the completion of the process. The change from green to yellow, along with other necessary changes, takes place chiefly while the leaf is still living. At temperatures above 120° the leaf is rapidly killed, so that this limit must not be exceeded during the yellowing process. Care must be taken to avoid drying the leaf too rapidly at the beginning, but as it begins to yellow the humidity in the barn must be decreased by slowly raising the temperature and gradually increasing the ventilation.

The completion of the yellowing process ends the first stage of curing, and then begins the critical period, commonly spoken of as "fixing the color." The object at this stage is to remove the moisture as fast as it is given off by the leaf. Plenty of ventilation is essential to success. If the leaf contains too much moisture when the yellowing has been completed, splotches of red or brown will soon begin to appear on the surface. This trouble, caused by insufficient ventilation toward the end of the yellowing, is known as sponging.

It is often too late to correct the trouble at this stage, but more ventilation may prove beneficial. If the heat is increased too rapidly while the leaf is still full of sap, a greenish-black color will develop, which is known as scalding, or blistering. The best results are obtained when the temperature is gradually increased throughout this phase of the curing until 130° to 135° F. is reached. Some growers follow the practice of raising the temperature rapidly to 125° or more and then quickly lowering it and opening the door and ventilators, repeating the process several times. This method is simply another way of removing excess moisture. It is not necessary if the barn is properly provided with ventilators.

The temperature should be maintained at 130° to 140° F. until the leaf is completely dried out, which will require 30 to 36 hours after the completion of the yellowing process. All danger from sponging or scalding will then be past, and it will be necessary only to dry out the stems. The ventilators should be nearly closed and the temperature raised to 165° to 170° at the rate of about 5° an hour. This temperature is maintained till all stems are completely dried out. Some growers raise the temperature to 190° or 200°, and even higher, but this greatly increases the danger of burning up the barn and contents, an accident by no means rare. These high temperatures cause the leaf to take on a reddish cast, and the process is known as scorching.

When the tobacco is harvested by cutting the stalk instead of picking the individual leaves, the final stage of drying must be prolonged for 12 to 24 hours in order to remove all moisture from the stalks. The whole curing process is completed in 4 to 5 days.

When the tobacco is to be taken down (fig. 8), the barn is left open during the preceding night, and the floor may be sprinkled, if necessary, so that the leaf may absorb sufficient moisture to bring it into condition for handling. If the leaf can be folded in the hand without breaking the stem, it is in proper condition to be taken down without injury.

SORTING AND HANDLING

When taken down, the bright tobacco is placed in bulks in shingle fashion without being removed from the sticks. To avoid injury

Figure 8.—Flue-cured tobacco barn interior, showing flues and cured leaf just prior to its removal following curing.

from mold, the bulk should be torn down at the end of a week or 10 days and rebuilt with all the butts pointing outward and the tips overlapping in the center. This treatment greatly improves the color of the leaf and especially assists in bleaching out the green remaining after the curing. It frequently happens that leaves showing a decided greenish cast will come from the bulk with a clear lemon-yellow color, provided the green has not been set by too rapid drying in the first stage of the curing.

When tobacco is prepared for market it is carefully sorted by the grower into different lots or grades. As a rule the different primings are handled separately and only a few lots are made of each. Six to ten different grades will usually be all that is made of the entire crop. On the farm the leaf from the early priming may be separated in lots commonly called trash lugs, sand lugs, and good lugs. Lots from later primings are usually known as best leaf, second leaf, tips, and green tips. The separation is based mainly on the position of the

leaf on the stalk, color, and extent of injury. Also, such other leaf characters as thickness, elasticity, and texture are highly important in the established market system of classification and are considered to a limited extent.

Flue-cured tobacco is classified on the market into six groups, which are determined mainly by the characters mentioned above. Beginning at the lower part of the plant, the normal groups are lugs, cutters, and leaf. Another group, known as wrappers, consists of leaves that are almost perfect, selected from the leaf and cutter group. Finally, two subgroups are made—primings in the lugs group and smoking leaf in the leaf group. The groups are further separated into three to six qualities, and each quality is again divided into colors. The most desirable colors, in order of preference, are lemon, orange, red, dark red, and green.

The system of classification obviously provides for a large number of possible grades and so permits close grading of all lots marketed. The tobacco of the different groups is used for different purposes. In general that from the lower part of the plant is used in cigarettes, while that from the upper part is used in smoking and chewing tobacco.

The prices obtained on the market are greatly influenced by the care and skill used in grading. This work requires experience and ability on the part of the grader to classify rapidly the colors and to determine accurately the other equally important but less easily recognized characters of the leaves. The graded leaves are carefully tied into hands, which are hung on sticks for 12 to 36 hours before they are marketed.

FIRE CURING

The use of open fires in curing is confined mostly to those sections growing the export types. The principal producing areas are embraced in some 20 counties of central Virginia, the Clarksville and Hopkinsville district, the Henderson district, and the Paducah district, the last three being included in that part of Kentucky and northern Tennessee west of the dark air-cured manufacturing districts of these States.

The old type of barn used for curing export tobacco is built of logs, the cracks daubed with mud. These barns are small but are generally high enough to contain five sets of tier poles. In recent years the log barns have been partly replaced by modern frame buildings of much larger size. These are provided with large doors opening into passageways leading through the building, thus allowing a loaded wagon to be drawn directly beneath the tier poles. These poles are arranged at intervals of about 3 feet 10 inches horizontally and 3 feet vertically, the first set being 8 or 9 feet above the ground. A type of barn in use in Kentucky and Tennessee is shown in figure 9, *B*.

MANAGEMENT

Usually no heat is required during the first stages of yellowing fire-cured tobacco, for it would dry out the leaf too rapidly. It is important to avoid this drying out before the proper colors have been developed and other important changes brought about. From 3 to 5 days after harvesting, slow fires are started on the floor of the barn

and the temperature is maintained at 90° to 95° F. until yellowing has been completed. Thereafter the temperature may be slowly increased until 125° or 130° is reached and held at this point until the leaf tissue is pretty well dried out. Altogether, the fires are kept up for 3 to 5 days, or, in some sections, for a somewhat longer period.

Formerly it was the general practice to stop the fires when the leaf had begun to dry and allow it to soften by the flow of sap from the stem and by absorbing moisture from the air. The fires were then started again and the process of alternate drying and softening con-

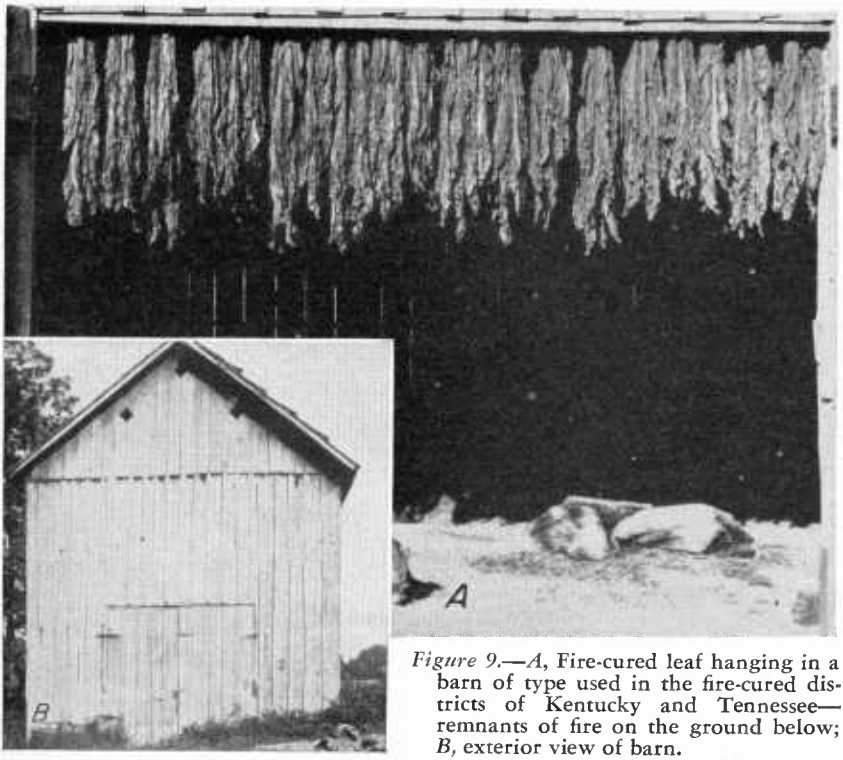

Figure 9.—A, Fire-cured leaf hanging in a barn of type used in the fire-cured districts of Kentucky and Tennessee—remnants of fire on the ground below; *B*, exterior view of barn.

tinued until the curing was complete. This practice is not so common now. The smoke from open hardwood fires imparts a characteristic odor and taste to the tobacco and improves its keeping qualities. The fire-curing procedures have changed somewhat, owing to the scarcity of fuel. As a consequence there is less firing, and hardwood sawdust has come into quite general use as a part of the fuel (fig. 9, *A*).

During the first stages of curing, when the tobacco is still full of sap, too much heat must be guarded against or parts of the leaf will be discolored by scalding, as in the case of flue-curing tobacco. Until the leaf is pretty well dried out, house-burn must be guarded against, and, if necessary, the fires should be started earlier, when more ventilation is required. After curing has been completed, slow fires should be started during periods of wet weather to prevent injury from molds and also too much darkening of the leaf color. Frequently the tobacco

is improved by bulking it down without removing it from the sticks, as already described for flue-cured tobacco.

STRIPPING AND SORTING

When the thoroughly fire-cured tobacco has become pliable by the absorption of moisture during a damp season, the plants are removed from the sticks and the leaves stripped off. Three principal grades are usually made—trash, lugs, and leaf—the preferred grades being used to a great extent in the manufacture of snuff, others for Italian cigars, and the cheaper grades mostly for the extraction of nicotine. The leaf grade is further subdivided into several grades based on size and color. The several grades are tied into neat bundles containing six to eight or more leaves.

In the Virginia fire-cured district the tobacco is auctioned loose, a method that has recently gained ground in the western districts, where formerly it was the general practice to pack or "prize" the leaf in hogsheads. Tobacco packed in hogsheads is sold by sample, so that careful sorting and packing are necessary if the highest market prices are to be obtained.

Tobacco in condition for winter handling will not keep through the spring. When warm weather sets in it will mold unless reordered by being again hung up to dry out. It is then ready to be taken down and packed in favorable weather and will keep indefinitely.

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